Improved Understanding of the Processes Controlling Tropospheric O_3 and CO_2 from Space-based IR Retrievals

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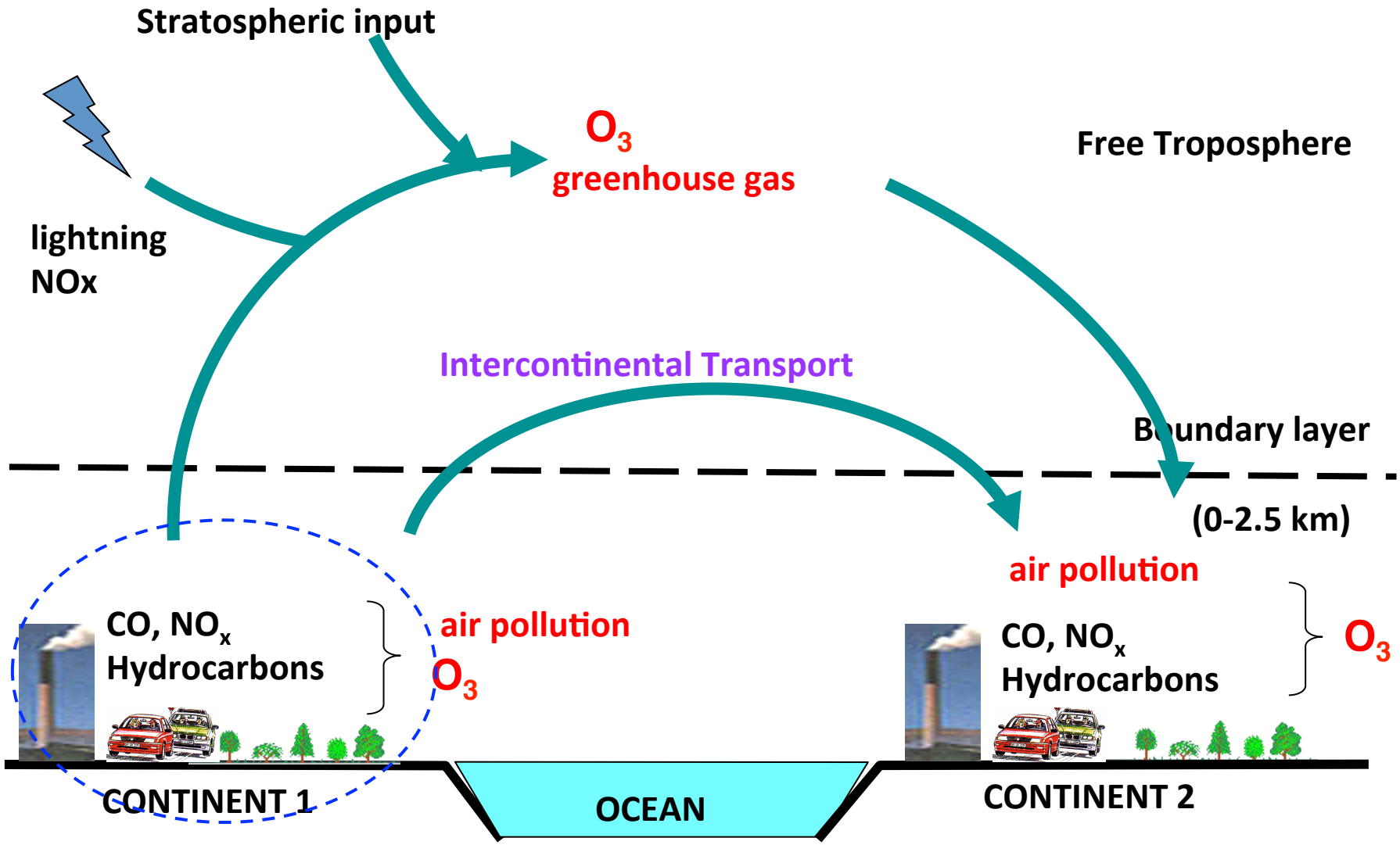
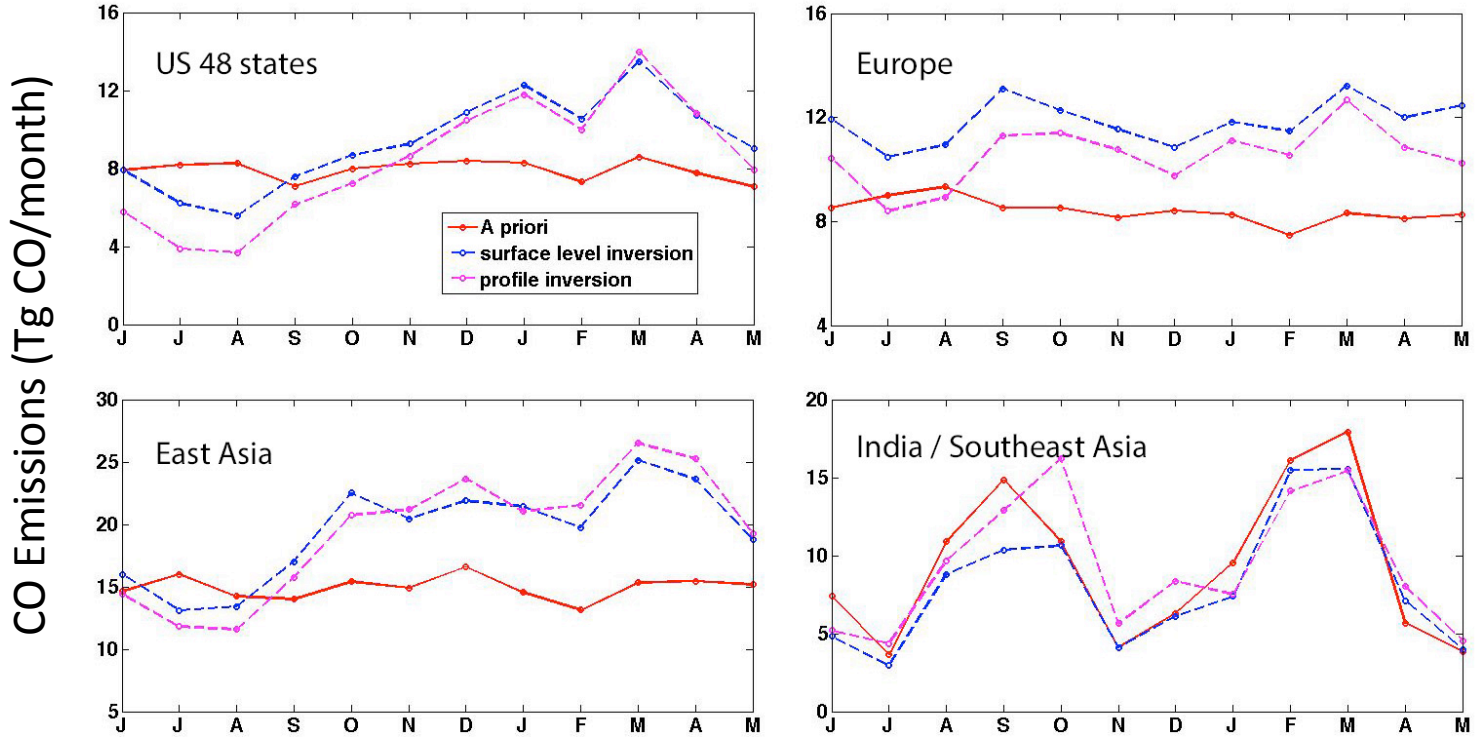
Processes Influencing the Global Distribution of Tropospheric O_3



Improved understanding of the processes influencing the global distribution of tropospheric O_3 is needed for better prediction of air quality and for quantifying climate change.

Inverse Modeling of CO

Regional CO Source Estimates for June 2004 – May 2005

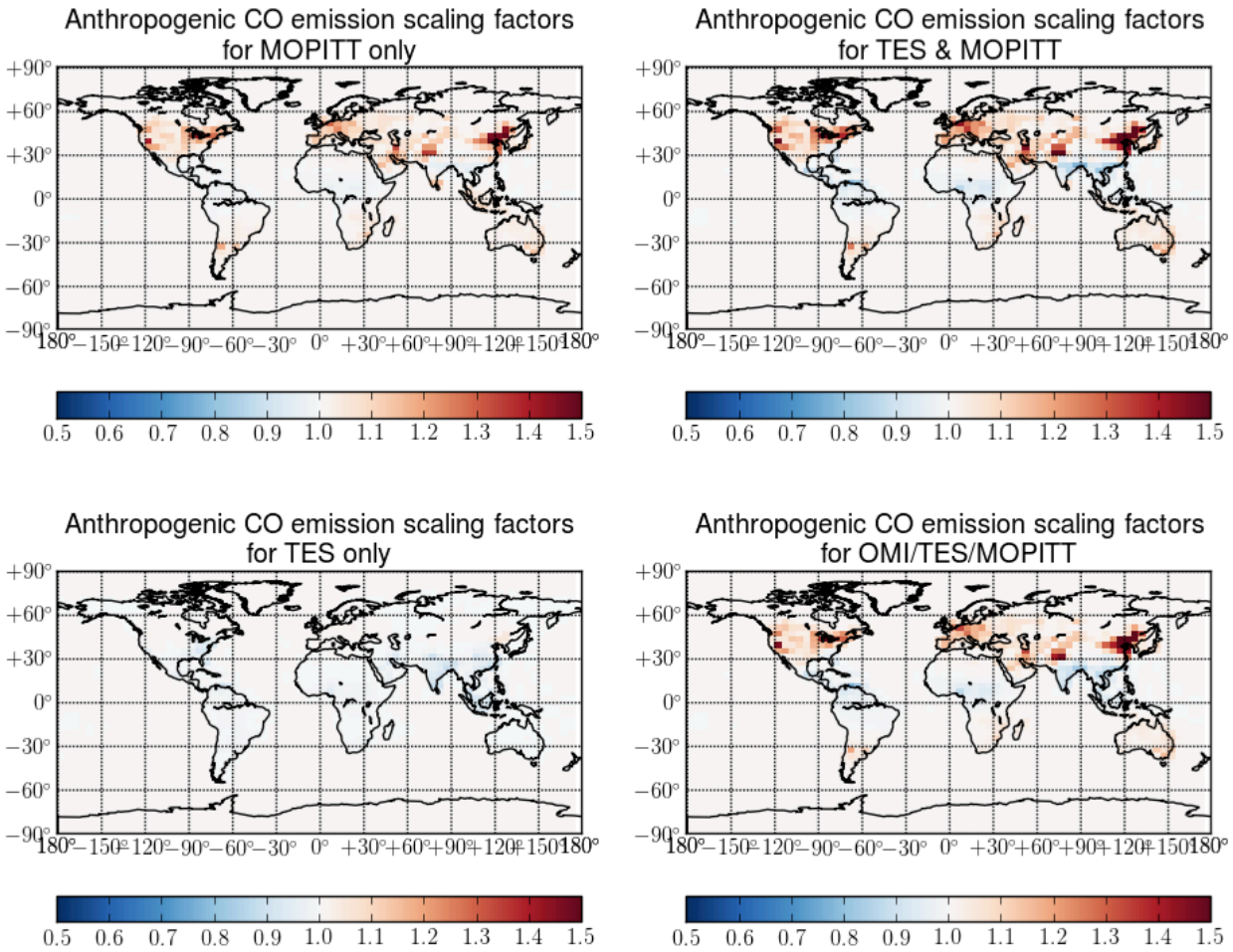


[Jiang et al., ACPD, 2014]

- Satellite observations of CO suggest greater emissions of CO in winter than a priori inventories in North America and East Asia.
- Season variation in top-down emissions, with greater wintertime emissions, is in agreement with previous work by Kopacz et al. (2009), but regional total are different.

Inverse Modeling of CO Using Multiple Trace Gases

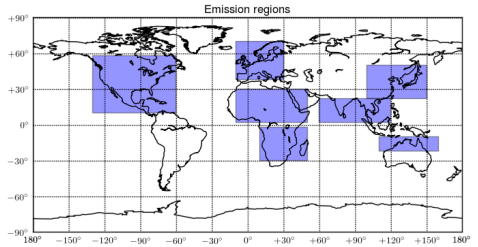
Assimilation of TES O_3, MOPITT CO, and OMI NO_2 Nov 2- 15, 2009



- Integrating TES O_3 and OMI NO_2 produces larger source estimates in the extratropics (particularly East Asia)
- With TES O_3, the reductions in CO emissions in South Asia are enhanced

[Keller et al., in prep]

Inverse Modeling of CO Using Multiple Trace Gases



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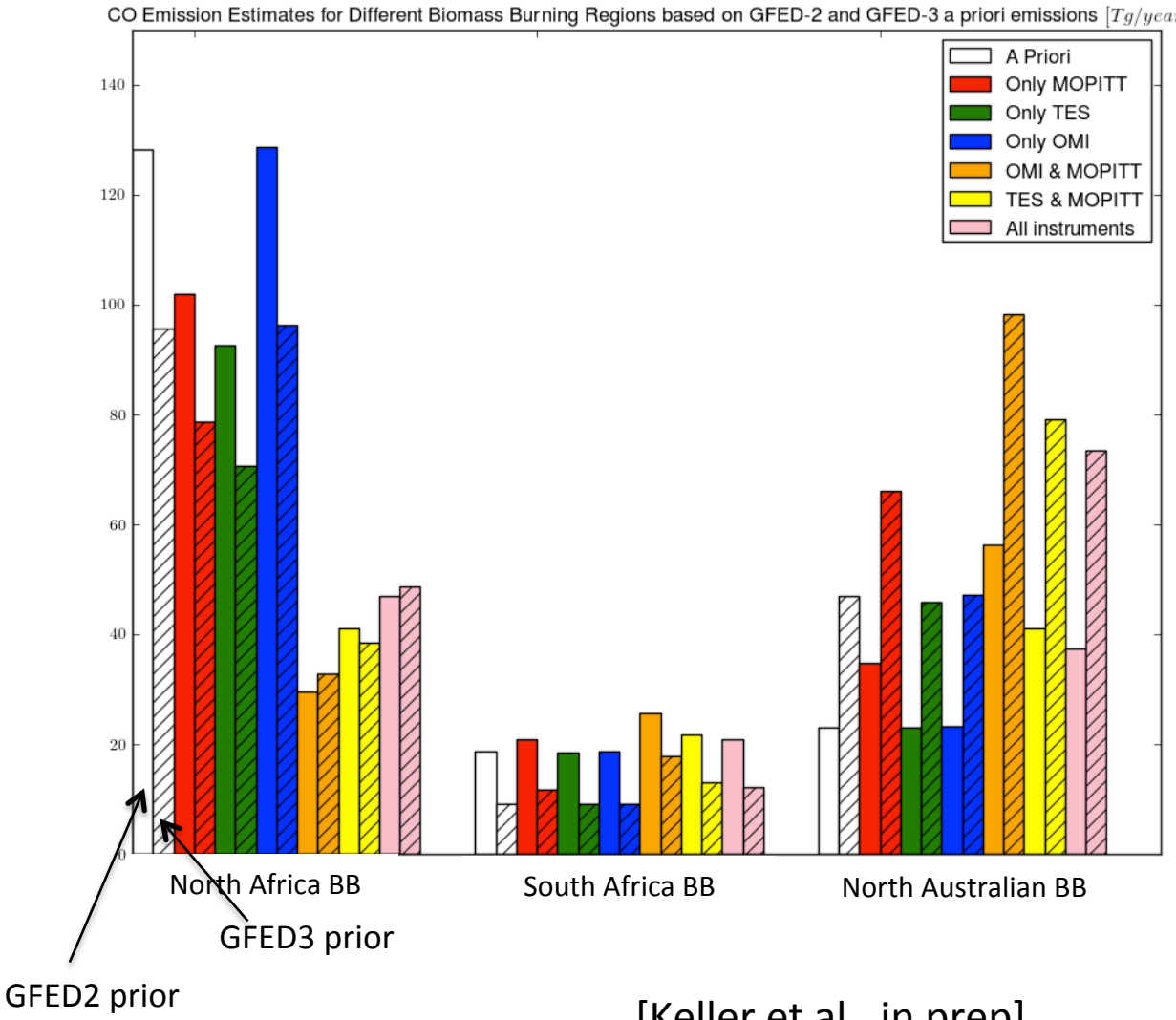
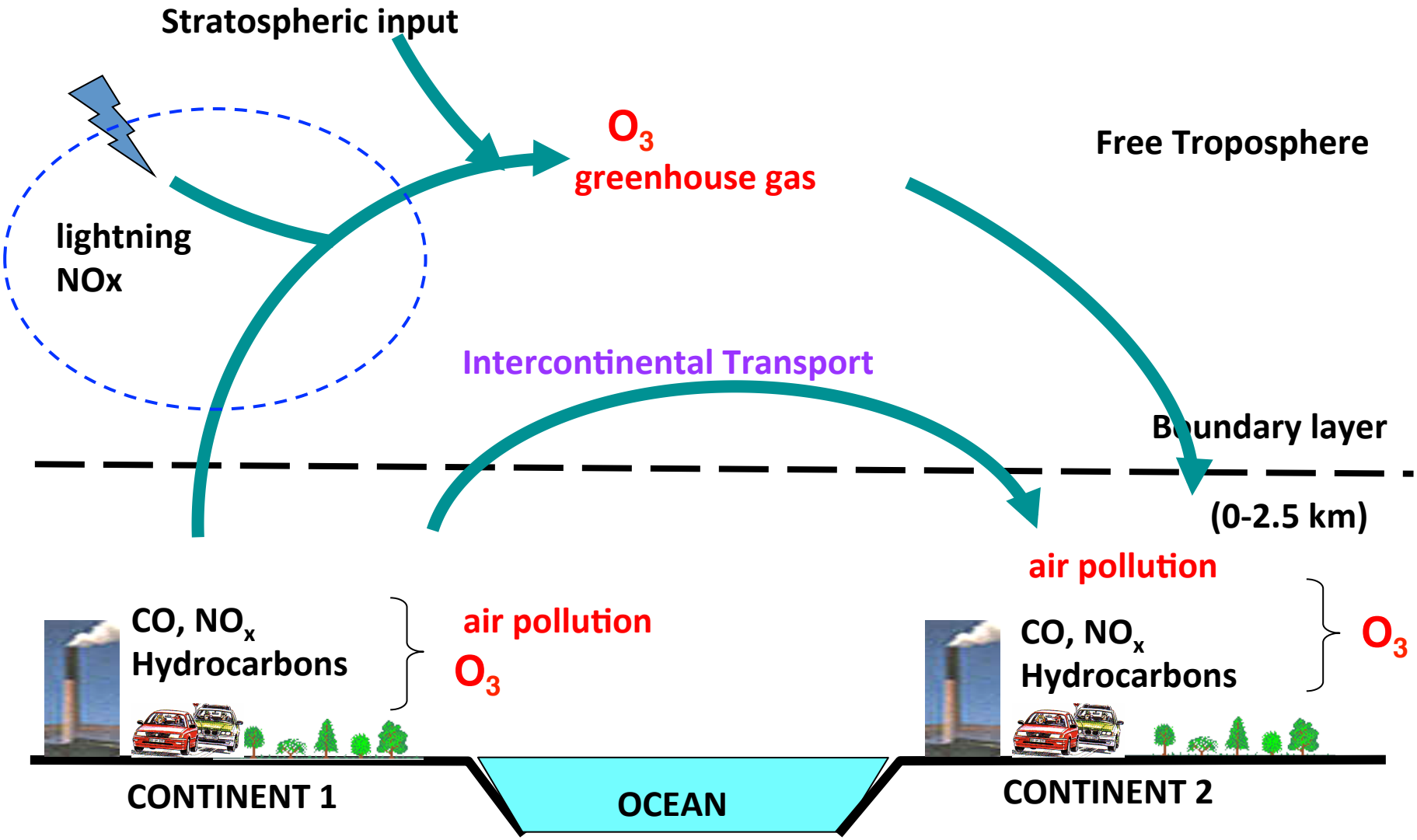


- Assimilating data from only one instrument produces a posteriori BB estimates that are sensitive to the prior
- For North Africa, assimilating all instruments provides sufficient information to strongly constrain the source estimate
- For South Africa and northern Australia, the a posteriori emissions are sensitive to the prior even when assimilating multiple instruments
  - ➢ Optimizing these weaker sources may require a longer assimilation window

[Keller et al., in prep]

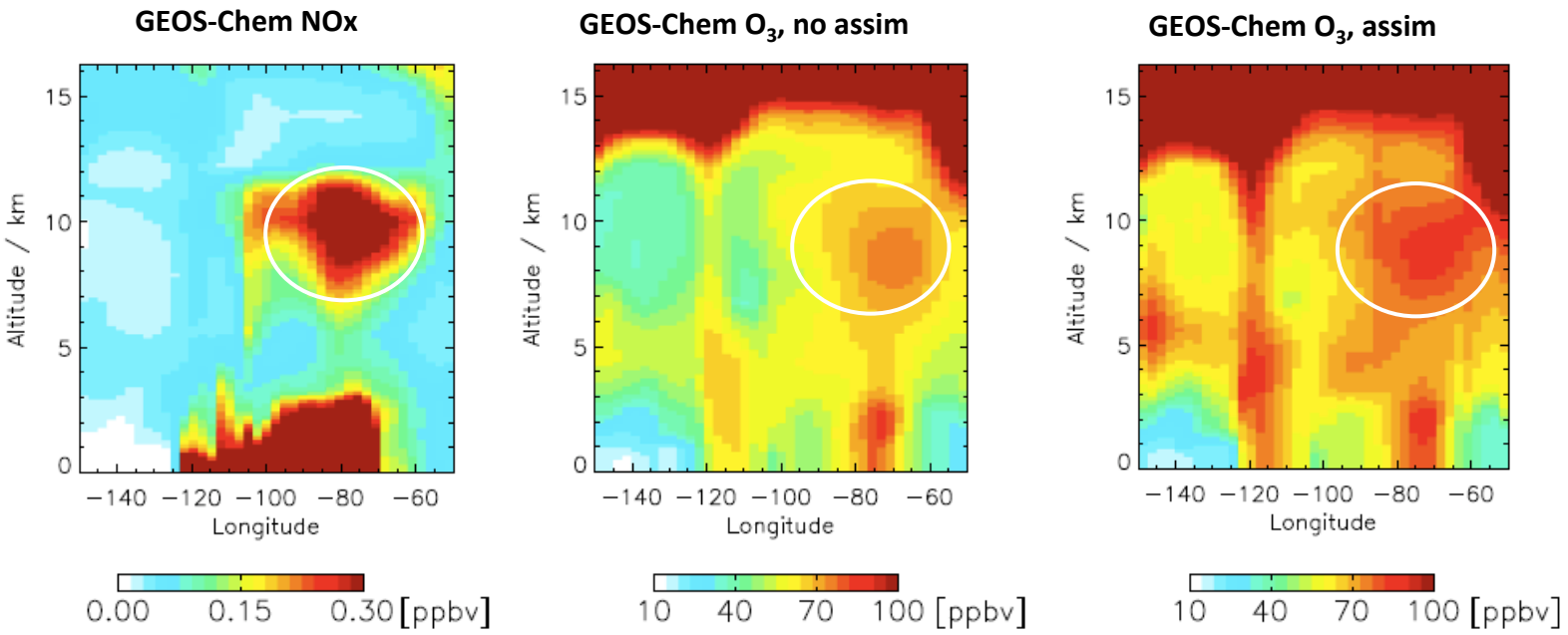
Processes Influencing the Global Distribution of Tropospheric O_3



Improved understanding of the processes influencing the global distribution of tropospheric O_3 is needed for better prediction of air quality and for quantifying climate change.

Impact of Lightning NOx Emissions on O_3 Over North America

Modeled O_3 Over North America along 40°N

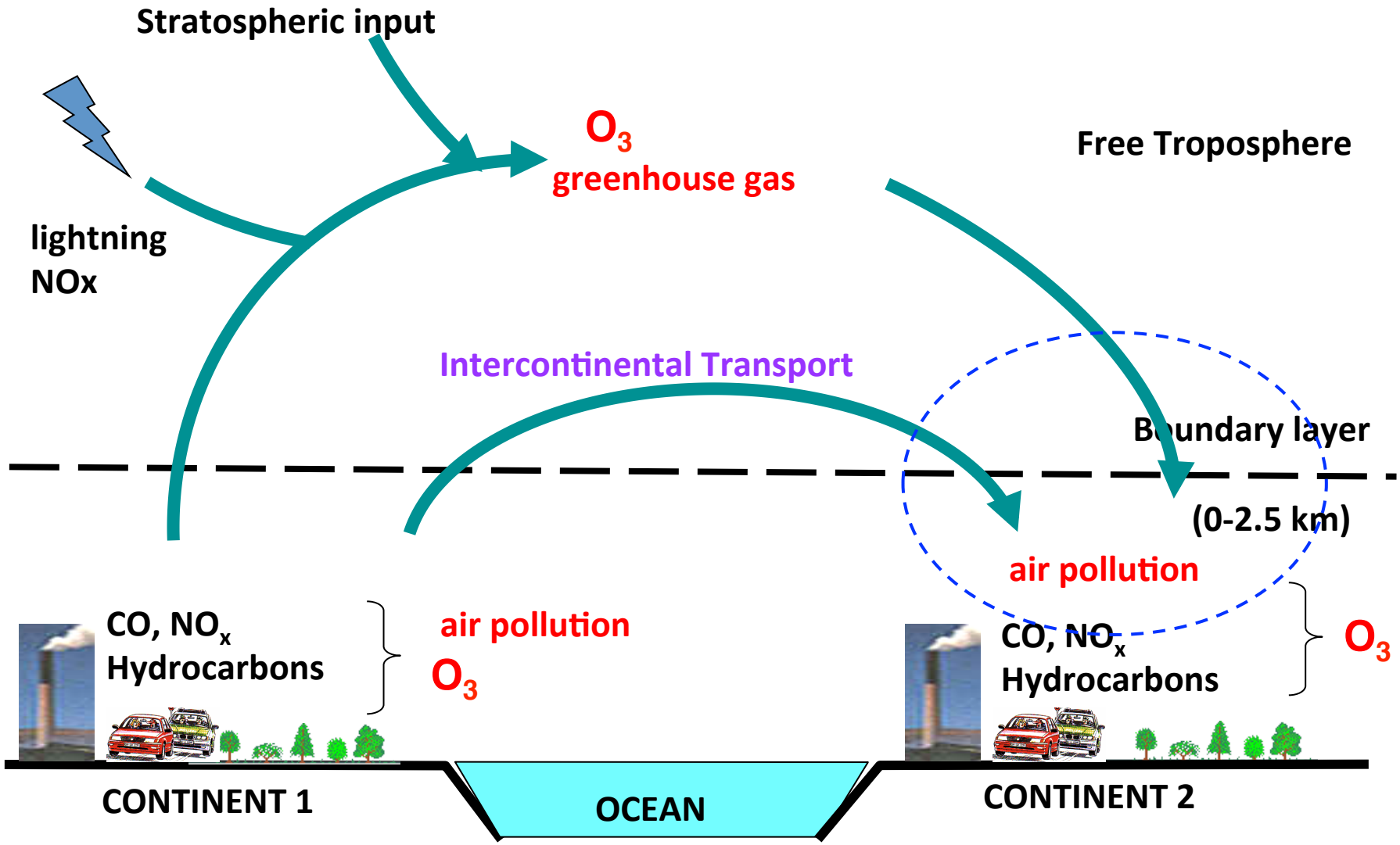


[Parrington et al., JGR, 2008]

- The upper tropospheric ozone maximum is linked to NOx emissions from lightning, which were 0.068 Tg N for North America (in August), a factor of 4 lower than recommended by Hudman et al. [JGR, 2007] based on comparisons of the model with aircraft data.

- Assimilation increased upper tropospheric ozone over the southeast by 11 ppb, in agreement with the estimate of 10 ppb from Hudman et al. [JGR, 2007] for the enhancement in upper troposphere ozone due to lightning NOx.

Processes Influencing the Global Distribution of Tropospheric O_3



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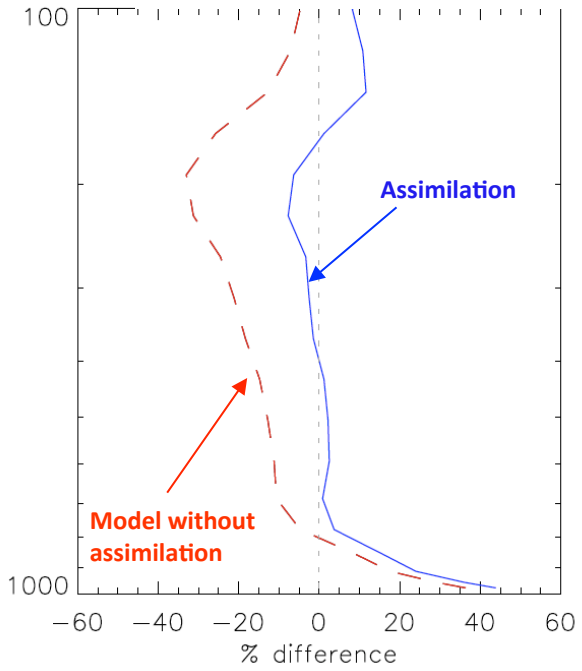
Satellite Constraints on background O_3

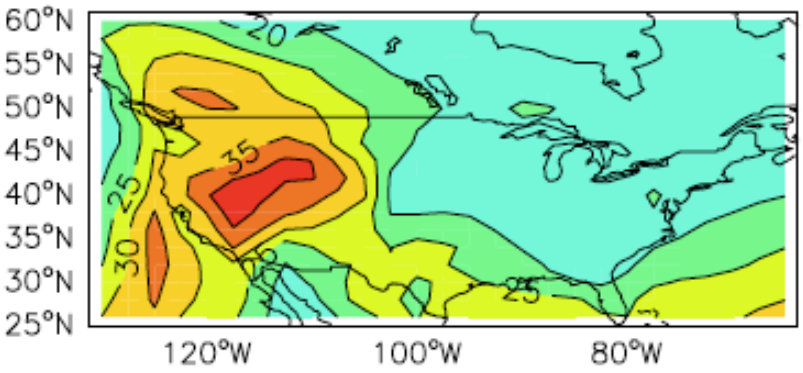
GEOS-Chem O_3 relative to ozonesondes in Aug 2006



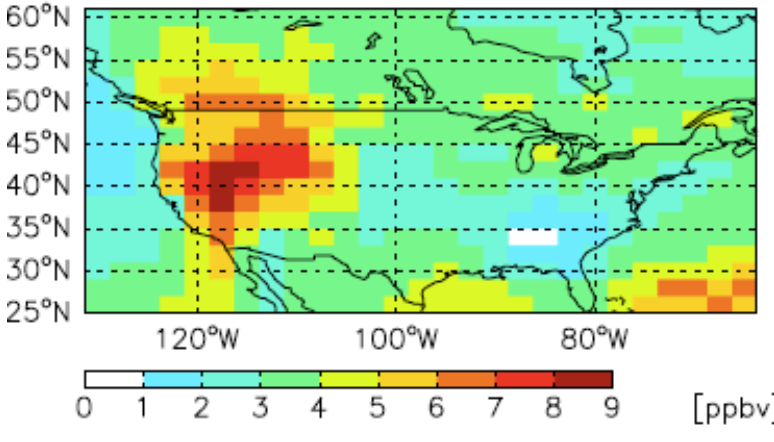
Assimilation of TES O_3 data Jul - Aug. 2006

- Assimilation of TES corrected the underestimate in O_3 in the model (due to lightning NOx emissions)
- Without assimilation the model underestimated background ozone by as much as 9 ppb (in western North America)

Background ozone at the surface, Aug. 2006

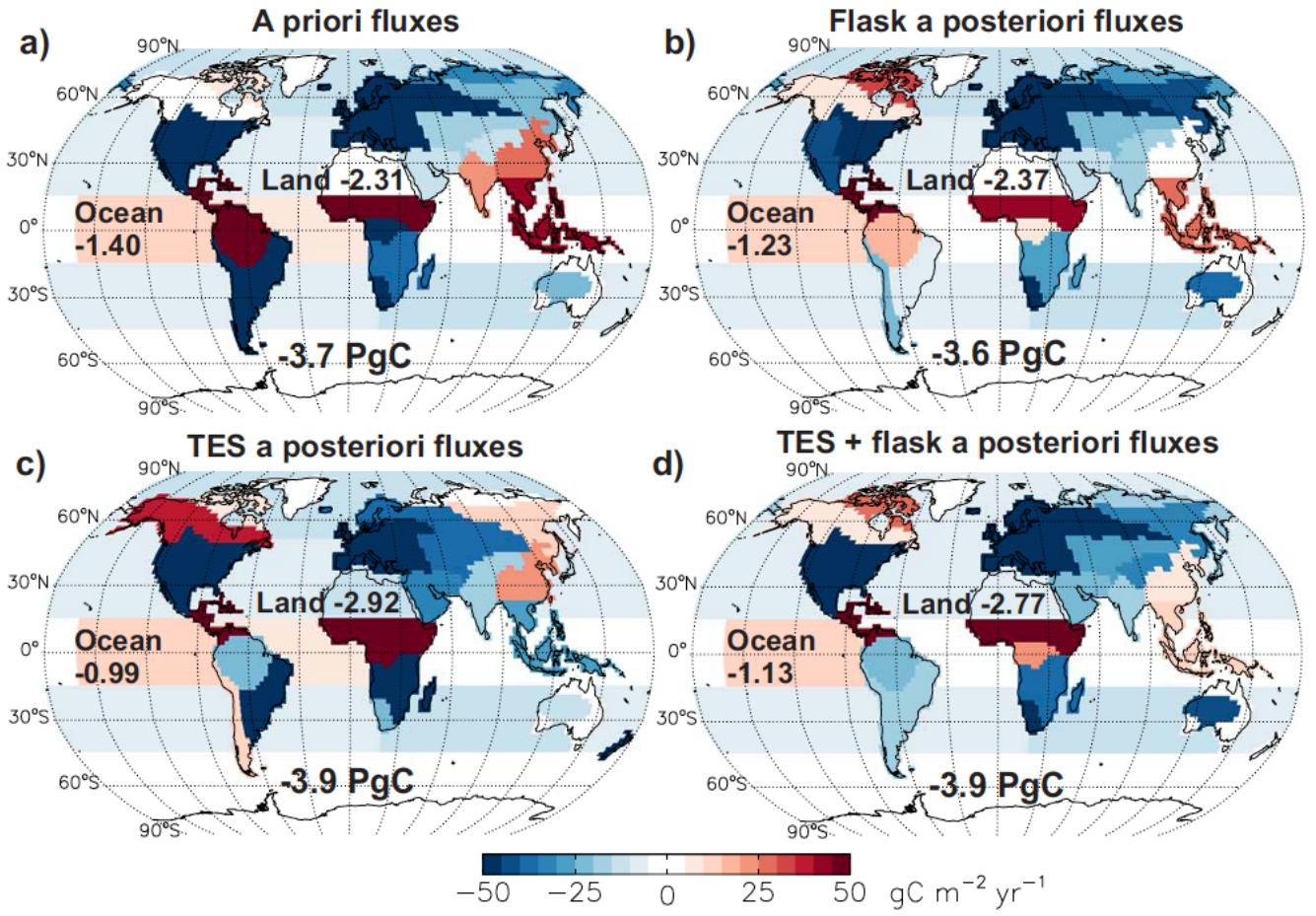


Error is background ozone without assimilation



[Parrington et al., GRL, 2009]

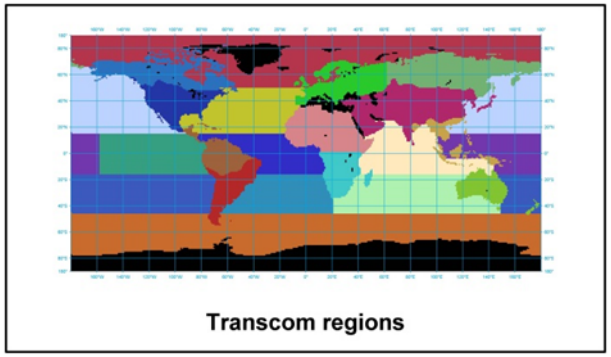
Inverse modeling of TES CO_2 data for 2006

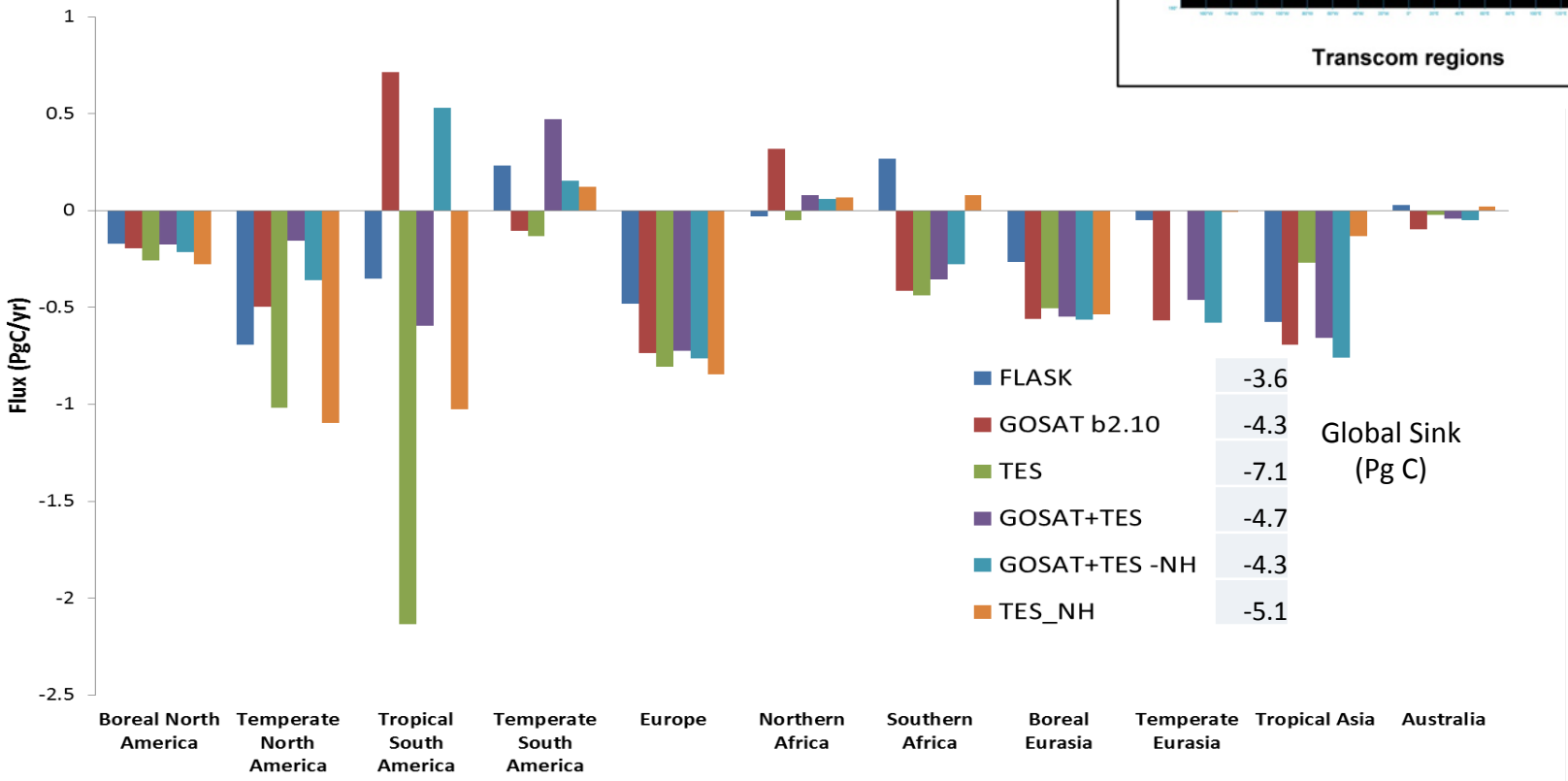


Free tropospheric CO_2 data provide constraints on surface fluxes of CO_2 that are complementary to those from the surface observing network.

[Nassar et al., ACP, 2011]

High-resolution inverse modeling of TES and GOSAT CO_2 for 2010

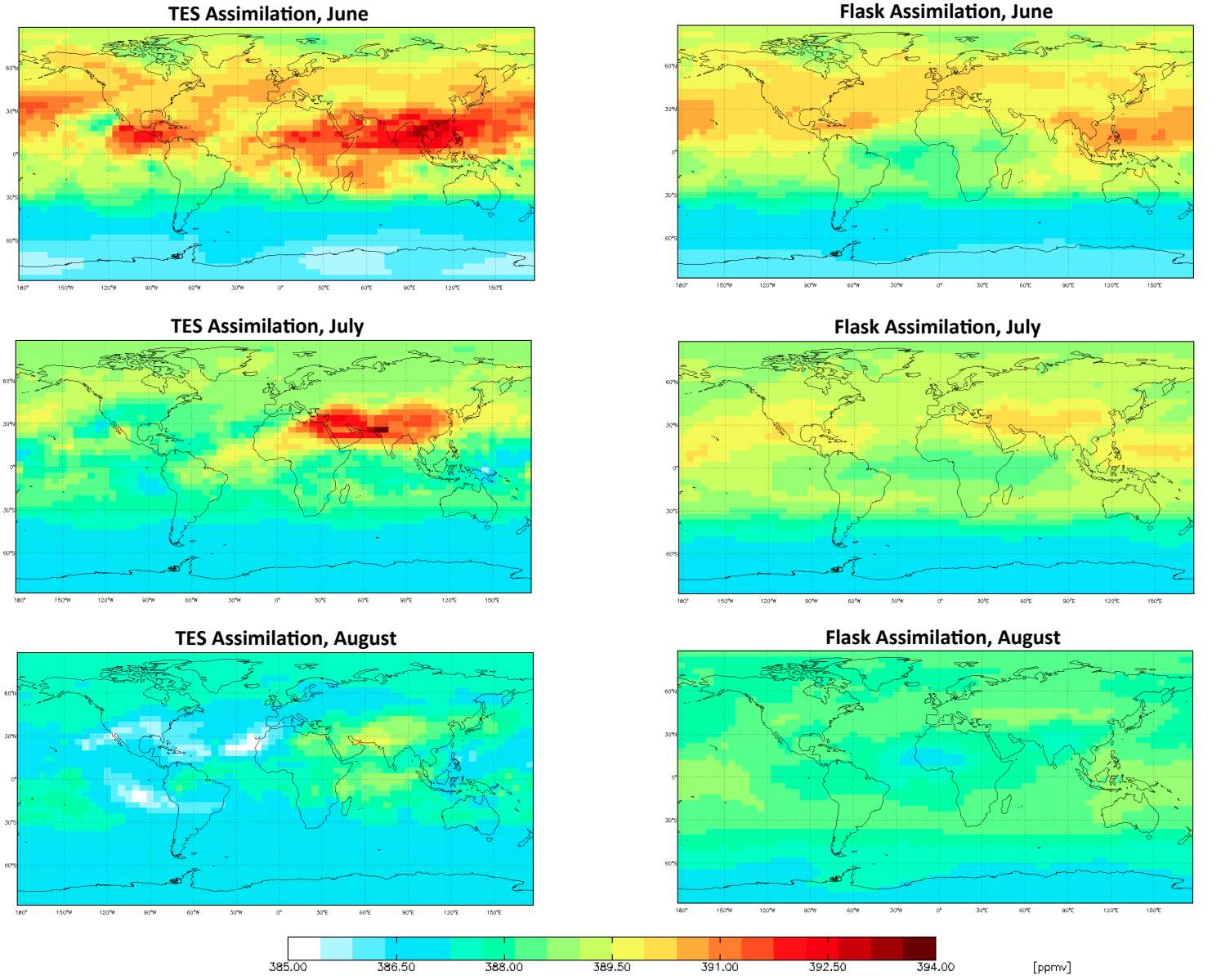




[Feng Deng, U. Toronto]

- TES and GOSAT Flux estimates for Europe and boreal Asia are consistent
- TES suggest a weaker sink in Temperate Eurasia and Tropical Asia
- Flux estimates from TES are biased low for Temperature North America and Tropical South America, reflecting the influence biases in TES CO_2 in the subtropics

Impact of TES CO_2 over the Asian Monsoon Region



TES assimilation enhances CO_2 in the Asian monsoon anticyclone